

Claims

- [c1] 1. A method for operating a hybrid electric vehicle (HEV) having a low voltage bus, a high voltage bus, and a DC convertor electrically coupling the low and high voltage busses, the method comprising:
controllably transferring energy from the high voltage bus to the low voltage bus during prestart of the high voltage bus by controlling energy flow through the DC/DC converter.
- [c2] 2. The method of claim 1 further comprising determining a battery energy level of a high voltage battery coupled to the high voltage bus, the high voltage battery for storing electric energy for use in precharging the high voltage bus, controllably transferring energy to the low voltage bus from the energy provided to the high voltage bus by the high voltage battery if the battery energy level is greater than a predefined energy level.
- [c3] 3. The method of claim 2 further comprising determining a battery state of charge for the high voltage battery, the battery energy equaling the battery state of charge.
- [c4] 4. The method of claim 3 further comprising determining

a battery power discharge limit for the high voltage battery, the battery energy equaling the battery power discharge limit.

[c5] 5. The method of claim 2 further comprising determining whether the high voltage battery energy is sufficient for powering an electric starter used for starting the vehicle, transferring energy to the low voltage bus only if the high voltage battery energy is sufficient for power the electric starter.

[c6] 6. The method of claim 5 further comprising continuously monitoring the battery energy, preventing further transfer of energy to the low voltage bus if the battery energy drops below a predefined energy threshold, the predefined threshold being greater than the energy needed for starting the electric starter.

[c7] 7. The method of claim 2 further comprising determining precharging by sensing an ignition key turned to a run position, determining prestart by closing opened contactors coupled between the high voltage battery and the high voltage bus once the high voltage bus is charged, and transferring energy to the low voltage bus only if the contactors are closed.

[c8] 8. The method of claim 1 further comprising determining

a battery voltage of a low voltage battery coupled to the low voltage bus, controllably transferring energy to the low voltage bus based on the battery voltage of the low voltage battery.

[c9] 9. The method of claim 8 further comprising limiting energy transfer to the low voltage bus if the battery voltage of the low voltage battery is greater than a predefined voltage.

[c10] 10. A vehicle system controller for operating a hybrid electric vehicle (HEV) having a low voltage bus for providing power to accessory loads and a high voltage bus electrically coupled to the low voltage bus by a DC/DC converter, the high voltage bus providing power for electric driving of the vehicle, the controller comprising: means for controllably transferring energy from the high voltage bus to the low voltage bus during prestart of the high voltage bus by controlling energy flow through the DC/DC converter.

[c11] 11. The controller of claim 10 wherein the controller further comprises means for determining a battery energy level of a high voltage battery coupled to the high voltage bus and controllably transferring energy to the low voltage bus from the energy provided to the high voltage bus by the high voltage battery if the battery energy level

is greater than a predefined energy level.

- [c12] 12. The controller of claim 11 wherein the controller further comprises means for determining a battery state of charge for the high voltage battery, the battery energy level equaling the battery state of charge.
- [c13] 13. The controller of claim 11 wherein the controller further comprises means for determining a battery power discharge limit for the high voltage battery, the battery energy level equaling the battery power discharge limit.
- [c14] 14. The controller of claim 11 wherein the controller further comprises means for determining whether the battery energy is sufficient for powering an electric starter used for starting the vehicle and transferring energy to the low voltage bus only if the battery energy level is sufficient to power a electric starter.
- [c15] 15. The controller of claim 14 wherein the controller further comprises means for continuously monitoring the battery energy and preventing further transfer of energy to the low voltage bus if the battery energy drops below a predefined energy threshold.
- [c16] 16. The controller of claim 11 wherein the controller further comprises means for determining prestart by sensing closing of opened contactors coupled between the

high voltage battery and the high voltage bus once the high voltage bus is charged and transferring energy to the low voltage bus only if the contactors are closed.

[c17] 17. The controller of claim 10 wherein the controller further comprises means for determining a battery voltage of a low voltage battery coupled to the low voltage bus and controllably transferring energy to the low voltage bus based on the battery voltage of the low voltage battery.

[c18] 18. The controller of claim 17 wherein the controller further comprises means for limiting energy transfer to the low voltage bus if the battery voltage of the low voltage battery is greater than a predefined voltage.

[c19] 19. A hybrid electric vehicle system, the system comprising:
an internal combustion engine;
a generator/motor for electrically starting the internal combustion engine;
a high voltage battery for storing high voltage energy;
a high voltage bus coupled between the generator/motor and the high voltage battery;
contactors coupled between the high voltage battery and the high voltage bus to electrically isolate the high voltage battery from the high voltage bus when opened;

a precharging device for precharging the high voltage bus prior to closing of the opened contactors;
a low voltage battery for storing low voltage energy and powering accessories;
a low voltage bus coupled between the battery and the accessories;
a DC/DC converter coupled between the high voltage bus and the low voltage bus, the DC/DC converter being isolated from the high voltage battery when the contactors are opened; and
a vehicle system controller, the vehicle system controller including instructions for controllably transferring energy from the high voltage bus to the low voltage bus during prestart of the high voltage bus by controlling energy flow through the DC/DC converter.

[c20] 20. The system of claim 19 wherein the vehicle system controller further comprises instructions for transferring energy to the low voltage bus only if a high voltage battery energy is sufficient for powering the generator/motor for starting the engine.